1. PALAEOBOTANICAL INVESTIGATIONS ON PLANT IMPRESSIONS AND SPOROMORPHS FROM EGYPT

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Abstract

Impressions of fragments of vegetative and reproductive organs of a few members of *Bennettitales* including a new species of male organs; *Williamsonia aegyptiaca* sp. nov. and two new foliage species; *Otozamites major* sp. nov. and *O. daragii* sp. nov., as well as impressions of fragmentary remains of conifers are recorded from presumably Lower Cretaceous beds in the western side of Gulf of Suez. All fossils except *O. major* are recorded for the first time from Egypt. Three samples containing plant macro-remnants were investigated palynologically. Lower Cretaceous spore-pollen assemblages were found.

Key words: Palaeobotany, macro- and micro-remnants, Lower Cretaceous, Egypt.

Introduction

The location of Abu-Darag area and a brief description of its geology were previously given in a preliminary paper by El-Saadawi and Farag (1972). Their paper included also drawings of two vertical sections of the two kaolin quarries D and H of the locality. These two sections showed the sequence of different kinds of strata in the two quarries. They also showed the presence of plant remains in only three beds; namely beds g and w of section H and bed v of section D. A brief description of the construction and thickness of the three fossiliferous beds, as well as, a description of the principal fossils (*Otozamites* sp. and cf. *Phlebopteris*) were given.

Material and Methods

The first author (W. El-Saadawi) visited the locality several times, and his collection (kept at the Botany Department, Faculty of Science, Ain Shams University), now includes over 200 specimens coming from the three beds as follows:

172 Slabs from bed g of section H,
5 Slabs from bed w of section H,
8 Slabs from bed v of section D,
23 Loose specimens.

The flora of bed g consists of fragmentary remains of bennettites, ferns a few conifers and some other unidentifiable plant remains. All are preserved as impressions with no organic matter left. The fossil plants of bed v of section D are also in the form of impressions but there is always a thin carbonaceous film left. In this bed neither bennettites nor conifers were found, only ferns or fern-like foliage in addition to some insect remains. The five slabs of bed w; which most probably represents a natural extension of bed v, and the 23 loose slabs have not yet been examined. The description of the fossil flora of Abu-Darag is proposed to be in a series of papers; I-*Bennettitales* and *Coniferales,* II-*Filicales* and other unidentifiable plant remains of bed g, III-The flora of beds w and v and the associated insect remains, IV-The succession of plant remains in the three fossiliferous beds and the bearings of the floras as a whole on the geology of the area and the age of the strata which is presumed to be Lower Cretaceous (ABDALLAH et al., 1963).

For the investigation of the plant microfossil remnants the samples were treated first with HCl. After washing with water HF was added to the organic matter containing residue to eliminate the silicates and other inorganic components. Finally, the slides for light-microscope investigations were prepared in glycerin-jelly.

Results

PLANT MICROFOSSILS

I—A. *BENNETTITALES*

The remains of this group of plants represent dominant components of the flora of bed g. The vegetative organs are abundant whereas the fructifications are rare. Thus out of the 172 slabs of bed g: 74 slabs contain fragments of one type of leaf, 22 slabs contain fragments of a second type of leaf, and 7 contain fragments of male organs.

The male reproductive organs are assigned to the genus *Williamsonia*. The leaf types are assigned to the genus *Otozamites*. Fronds of the latter genus are know to be borne on trunks and branches of the former.

DESCRIPTION OF THE FOSSILS

CYCADOPSIDA

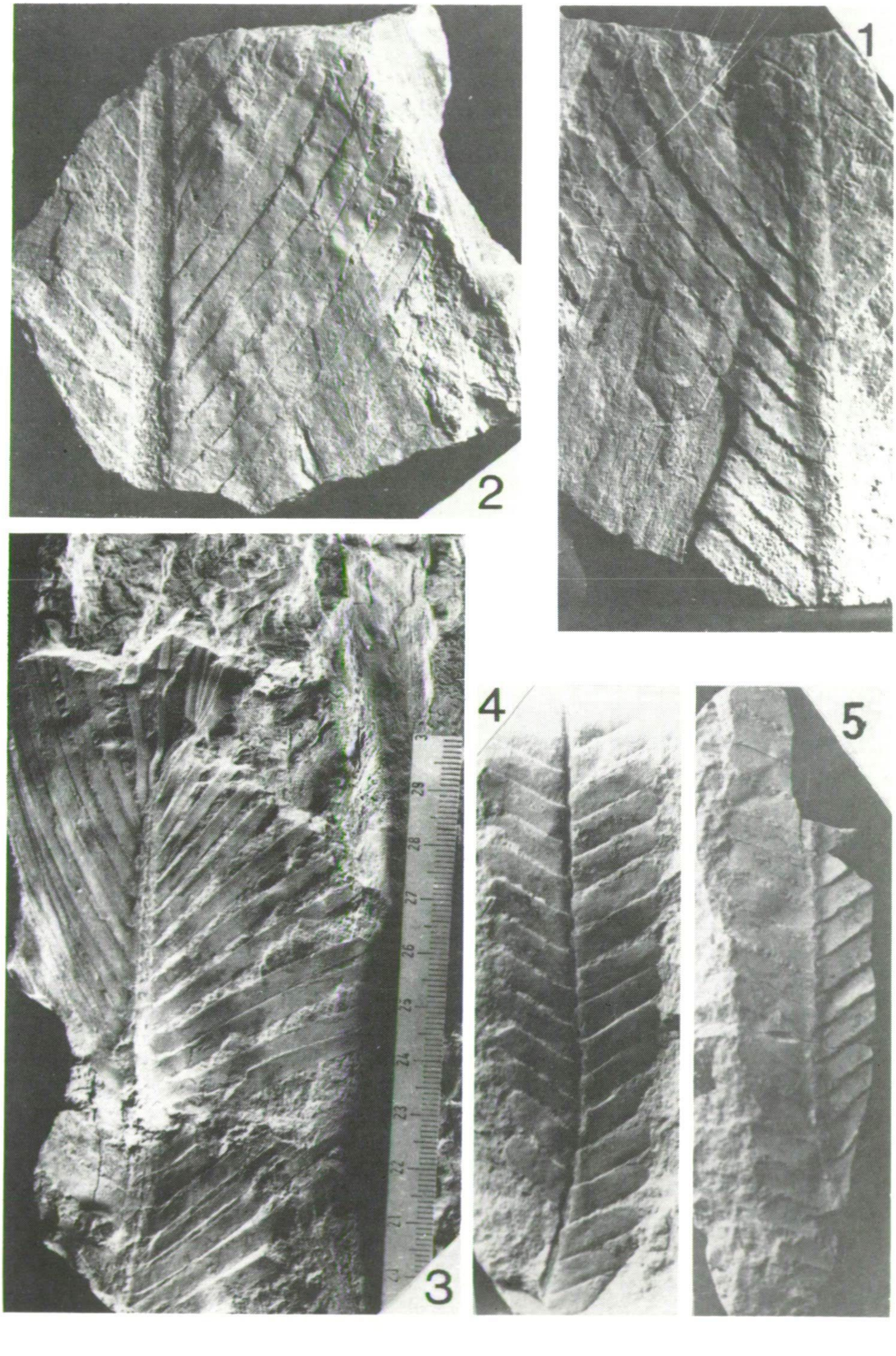
BENNETTITALES

WILLIAMSONIACEAE

Otozamites Braun.

Otozamites major sp. nov.
(Plate 1.1., fig. 1—3, plate 1.3., fig. 8, text-fig. 1.1., 1.2.)

Remark. — Although this species is represented in a large number of slabs (74) yet unfortunately its remains are fragmentary and the shape of the leaf as a whole remains unknown. Nevertheless, the following description and establishment of a new species is based on the study of this large number of specimens.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◀ Plate 1.1.

1. *Otozamites major* sp. nov. Impressions of a fragment showing adaxial surface and pinnae bases. Specimen H 73. Magnification 0.75 x.
2. *Otozamites major* sp. nov. Counter part, showing abaxial surface. Specimen H 73. Magnification 0.75 x.
3. *Otozamites major* sp. nov. Impression showing leaf apex (an impression of a *Pinus* stem is seen in the right upper corner of the figure). Specimen H 54. Magnification 0.76 x.
4. *Otozamites daragii* sp. nov. Impression of the lower half of a frond showing abaxial surface. Specimen H 30. Magnification 1.14 x.
5. *Otozamites daragii* sp. nov. Counter part of the same specimen showing pinnae bases. Specimen H 30. Magnification 0.92 x.

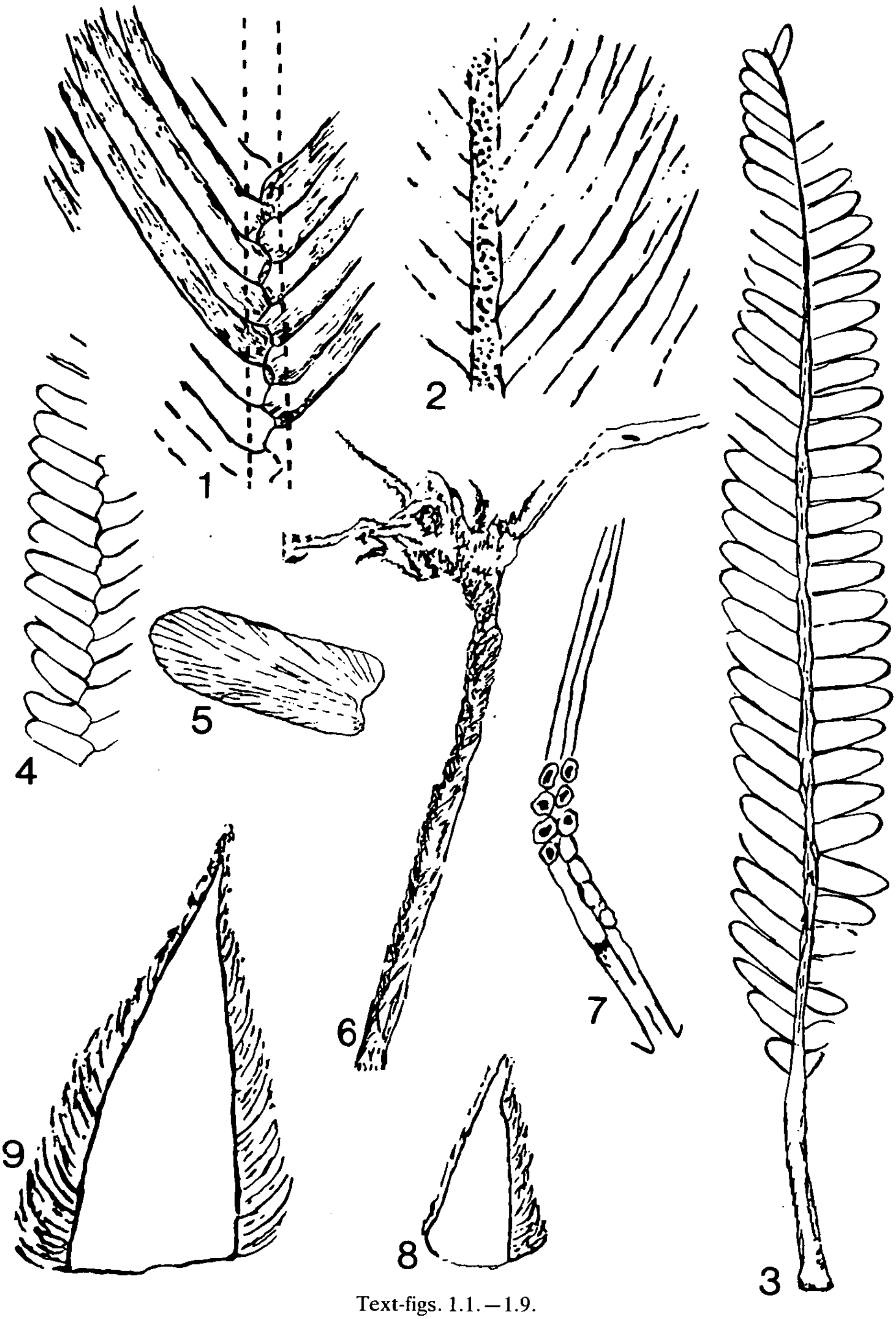
Diagnosis and description

The largest specimen is a leaf fragment about 20 cm long. The lower end of its rachis is 9 mm wide and there is a gradual decrease in width towards leaf apex. Complete small pinnae are 3.5—5 cm long and 3.5 to 6 mm broad. Larger pinnae; 9 mm wide were found. These large pinnae were incomplete at their upper ends, however, their length may be estimated at 15 cm. The pinna tapers very gradually towards its apex. The latter is rounded and not sharply pointed. The pinnae may be straight, slightly or somewhat strongly curved (Plate 1.3., fig. 8). The angle of insertion of the pinnae on the rachis is generally between 45° and 55°. The pinnae are closely set together but sometimes there is a narrow gap; usually under 2 mm in between. The pinnae cover the upper surface of the rachis completely so that the auricles generally overlap and the lower margin of each pinna overlaps the upper margin of the pinna below (text-fig. 1.1.). The lower surface of the rachis is finely ornamented (text-fig. 1.2.). The preservation of some pinnae was good enough to show some 18 veins that are slightly divergent at the rounded base of the pinna but are paralell upwards. It is not clear whether these veins were devided or not. Both margins of the pinna are incurved at the base. The latter is asymmetric with an acroscopic auricle (text-fig. 1.1.). The pinnae are flat with entire margins. The material of the lamina is not thick and the veins are somewhat more prominent on the lower than on the upper surface.
Comment. — This species of *Otozamites* being present in a large number of slabs is therefore, closely associated with almost all other fossil plants present in bed g.

Otozamites daragii sp. nov. (Plate 1.1., fig. 4, 5, plate 1.2., fig. 6, 7, text-fig. 1.3—1.5.)

Diagnosis and description

This species also has a once pinnate frond but is much smaller than the previous species. Many fragments were met with in 22 slabs. An almost complete frond is shown in text-fig. 1.—3., and Plate 1.2., fig. 6, 7. The leaf has an elongated lanceolate shape and is 2.5—3 cm broad. Its full length might have been 25 cm. The pinnae are generally 12 mm long and 3.7 mm wide. Extreme length and width are 18 mm and 4.5 mm respectively. Smaller pinnae were recorded. The pinna is



Text-figs. 1.1. — 1.9.

1.1, 1.2. *Otozamites major* sp. nov.
1.3 — 1.5. *Otozamites daragii* sp. nov.
1.6., 1.7. *Williamsonia aegyptiaca* sp. nov.
1.8., 1.9. Hairy-bracts (*Williamsonia* sp.)

straight; the two margins of the lamina run parallel throughout most of the length of the pinna and the apex is broadly rounded (text-fig. 1.3.—1.5.). The auricle is scarcely developed in some of the pinnae and undetected in others, but there are usually auricular veins (text-fig. 1.5.). The lower margin of the lamina is clearly incurved at the base in some pinnae. In other pinnae it was difficult to determine whether it is incurved or decurrent. Veins are divergent, branched, and about 14 of them traverse the lamina at its centre. The angle of insertion of the pinnae on the rachis is generally about 60°. The specimen shown in text-fig. 3 (see also Plate 1.2., fig. 6, 7) has one row of pinnae with the usual angle of insertion (60°). While the other row has a wider angle of about 80°. Such difference in the angle of insertion of the two rows of pinnae of a leaf is sometimes seen in pinnate leaves of some extant plants. What is interesting to note is that in the present specimen the pinnae of the row with a wide angle are evidently shorter and broader than those of the opposite row. This is possibly due to the slope of the rachis during the life of the plant. The pinnae are closely set and possibly overlap at the base. The ornamentation pattern of the lower surface of the rachis is different from that of the previous larger species. The pinnae are flat with entire unspecialized margins. The material of the lamina is thin.

Comment. — Similar to the previous species this one is also closely associated with almost all other plant remains present in the bed.

Williamsonia CARRUTHERS

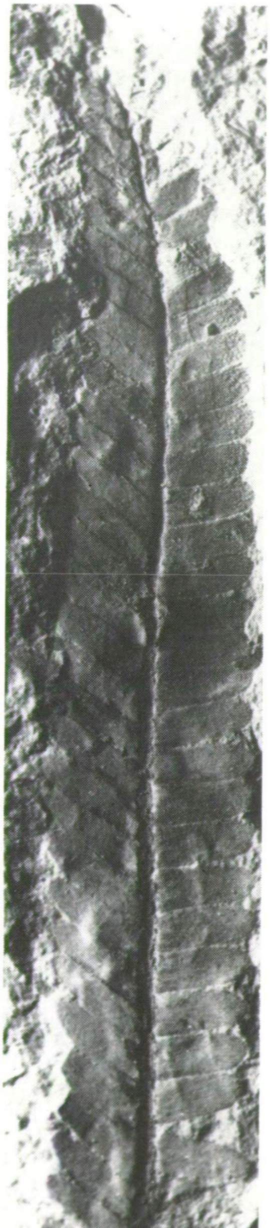
Williamsonia aegyptiaca sp. nov. (Plate 1.3., fig. 9, text-fig. 1.6., 1.7.)

Remark. — Fragments of male organs, especially the pedicels were met with in 7 slabs, usually in close association with *Otozamites daragii.* Line drawing of the best specimen (Plate 1.3., fig. 9) is shown in text-fig. 1.6. It is mainly upon this specimen that the following description and establishment of a new species *Williamsonia aegyptiaca* is based.

Diagnosis and description

This male flower has a long pedicel of a uniform breadth of about 1 cm throughout the portion preserved which is over 20 cm long. All recorded pedicels were of about the same breadth ranging between 10 and 12 mm. Pedicels must have been thick since they are preserved as moulds. The specimen shown in text-fig. 1.6. represents almost half the male organ with about 8 microsporophylls which are united at their base in the form of a cup.

The microsporophyll after becoming free from the basal cup moves obliquely upwards and outwards for a length of about 5 cm then it bends and stretches more horizontally for six more centimeters. This however, does not represent the entire length and shape of the microsporophyll since the distal end is not preserved. However, the entire length of the microsporophyll may be estimated at 14 cm. The diameter of the basal cup is about 3.5 or 4 cm. Therefore, the diameter of the fully expanded "flower" might have been 25—30 cm. The adaxial surface of the



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◀ Plate 1.2.

6. *Otozamites daragii* sp. nov. Impression of the major part of a frond showing lower surface. Specimen H 30. Magnification 1.14 x.
7. *Otozamites daragii* sp. nov. Counter part of a portion of the same in addition to the basal part of the leaf. Specimen H 30. Magnification 1.25 x.

sporophyll (see text-fig. 1.7.) has two rows of depressions; one row on each side of a median ridge. Each row consists of about 8 of these depressions which are supposed to represent the positions of the synangia. No remains of the latter were found. The microsporophyll is 6 mm wide at its middle part and 3.5 mm at its broken end.

Hairy-bracts (*Williamsonia* sp.) (Plate 1.3., fig. 10, text-fig. 1.8., 1.9.)

Six relatively large hairy bracts (most probably of *W. aegyptiaca*) were met with in six specimens. They were usually found in association with *Otozamites major*. They are broad with remarkably long marginal hairs which are curved upwards (Plate 1.3., fig. 10, text-fig. 1.8., 1.9.). The bracts vary in size to some extent and the largest bract (text-fig. 1.9.) measures about 50 mm in length and 1.5 cm (2.8 cm including the hairs) in breadth.

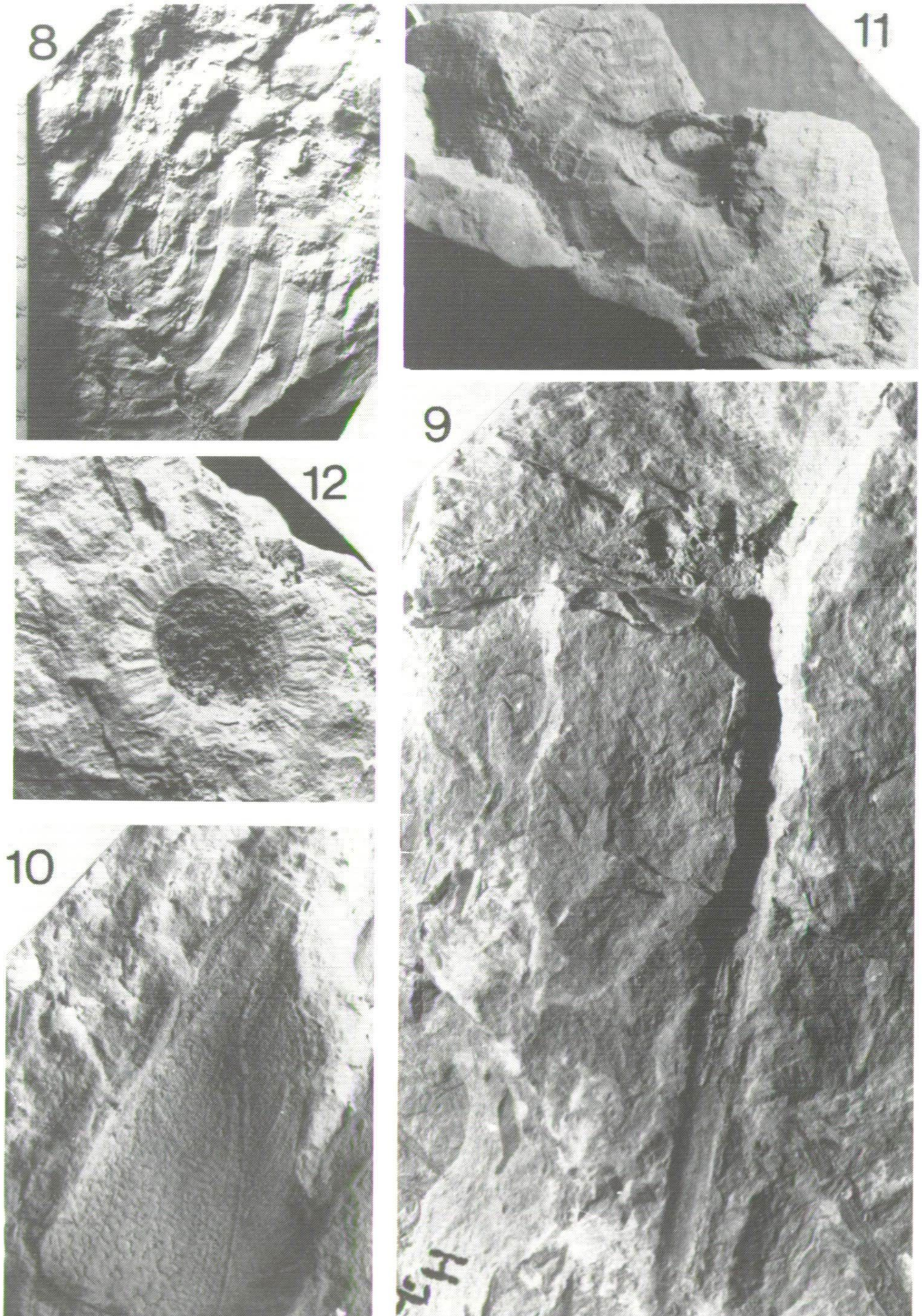
?Female "flowers" (of *Williamsonia aegyptiaca)* (Plate 1.3., fig. 11, 12)

Two specimens comparable to casts and moulds of the basal portion of *Williamsonia gigas* ovulate strobili (see later under comparisons) are shown on Plate 1.3., fig. 11, 12. The specimen shown in fig. 12 represents a mould of the basal portion of an ?ovulate cone. The maximum diameter of the portion preserved and illustrated is 16 mm. The rays or sterile organs surrounding the central, circular depression are about 3.5 mm long by 1 mm broad, and their number is about thirty. The second specimen (Plate 1.3., fig. 11) represents a cast of the basal portion of an ?ovulate cone about 5 cm in diameter. The position of the pedicel is shown as a hollow space surrounded by a number of basal scales.

Identification

Comparing *Williamsonia aegyptiaca* and the two species of *Otozamites* described in this work with all forms of the two genera described and illustrated in the available literature showed that they could not be accomodated in any of them. Naturally they approach some of them more closely than others but they remain distinct from them all. Since the comparison included a relatively large number of species, therefore, it was plausible to establish the three new species.

Otozamites daragii sp. nov. is so close to the boundary between *Otozamites, Ptilophyllum* and *Zamites*. But according to the definition of Harris (1949a) it should be included in the genus *Otozamites* for the characteristic type of the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◀ Plate 1.3.

8. *Otozamites major* sp. nov. Fragment showing curved pinnae. Specimen H 5. Magnification 0.7 x.
9. *Williamsonia aegyptiaca* sp. nov. Impression showing long pedicel and about 7 microsporophylls. Specimen H 24. Magnification 0.64 x.
10. *Williamsonia* sp. Hairy bract, showing long marginal hairs. Specimen H 26. Magnification 1.8 x.
11. *Williamsonia* sp. Cast of an ?ovulata cone. Specimen H 14. Magnification 1.25 x.
12. *Williamsonia* sp. Mould of an ?ovulate cone. Specimen H (Hb) 33. Magnification ca 2 x.

venation of pinna base, if not for the presence of an acroscopic auricle and an incurved basiscopic margin in some of the pinnae.

The hairy bracts and the ?ovulate cones do not offer sufficient information regarding their structure and organic connection to allow for more precise determination than rather assigning them to the genus *Williamsonia.*

COMPARISONS

The two new species of *Otozamites* of Abu-Darag were compared with more than 20, mainly Jurassic, forms of that leaf genus, e.g. with those illustrated and described by ARNOLD (1947), EDWARDS (1929a,b), HARRIS (1944, 1949a,b), MÄGDEFRAU (1956), SAHNI and RAO (1933), SEWARD (1911, 1917), SPORNE (1965), THOMAS (1913), TRALAU (1968) and WIELAND (1916). The comparison showed clearly that the two species of *Otozamites* of Abu-Darag could not be accomodated in any species of the genus. However, *Otozamites daragii* has some features in common with *O. feistmanteli* ZINGO which is described and illustrated by HARRIS (1949a), but it is more closely similar to *O. reglei* var. illustrated and described by WIELAND (1916) from the Jurassic of Oaxaca Mexico. WIELAND's (1916) figure 70 of *Otozamites reglei* var. is very similar to the line drawing of *O. daragii* shown in text-fig. 1.3. of the present work. However, there is a slight difference in the angle of insertion of the pinnae on the rachis. Those of *O. reglei* var. have slightly wider angle.

Williamsonia aegyptiaca agrees with *W. whitbyensis, W. spectabilis,* WIELAND (1916), and *W. santalensis,* SITHOLEY and BOSE (1953) (= *Weltrichia,* BOSE 1967), all of Jurassic age, more or less in the size of the basal cup. The new species agrees with *W. whitbyensis* in the manner in which the fertile organs (synangia) are arranged on the adaxial surface of the microsporophyll, but differs in this respect from all other male "flowers", e.g. *W. mexicana, W. spectabilis, W. santalensis.*

W. aegyptiaca differs from other species in the length of the microsporophyll; that of the new species being the longest. The microsporophyll also differs from others in its general shape and curvature. The diameter of the fully expanded "flower" of *W. aegyptiaca* is almost larger than that of all other flowers. The one nearest to it is *W. santalensis (= Weltrichia).* The pedicel of the new species is long and thick with no paralell in the other species. The latter are reconstructed without a pedicel or with a short slender one.

The hairy bracts of Abu-Darag are broader than any such organs described in literature, e.g. HARRIS (1953) and WIELAND (1916). In length they are as others. The hairy bracts of *Williamsonia harrisiana* (female flower) described by BOSE (1968) from the Jurassic of India have prominent marginal hairs that are very similar to those of Abu Darag's specimens.

The mould here, referred to as an ?ovulate cone resembles to a certain extent the "mould of basal portion of an ovulate cone of *Williamsonia gigas*" illustrated and described from the Jurassic of Yorkshire by WIELAND (1906). Abu Darag's ?ovulate cone mould shows also slight superficial resemblance to *Sturiella;* a bisexual "flower" referred to the *Williamsoniaceae,* ANDREWS (1961). Abu Darag's ?ovulate cone cast resembles to a certain degree the "Strobili casts of *Williamsonia gigas*" illustrated and described from the Jurassic of Yorkshire by WIELAND (1906, 1916). It also resembles the "cast of the ovulate-cone base of *Williamsonia netzahualcoyot*" described and illustrated in association with *Otozamites reglei* from the Jurassic of Mexico by WIELAND (1916).

I-B *CONIFERALES*

The flora of bed g is dominated by cycadophyte and fern remains whereas the conifers are quite rare. The following are the fossil conifer impressions discovered:

- Two stem-fragments of *Pinus.*
- One fragment of an *?Araucaria* twig.
- A fragment of a ?leaf.
- A single cone specimen (part and counter part).
- A single fragment of a ?cone (part and counter part).
- A single fragment of a stem with a ?cone base attached.
- Nine seeds (or ovuliferous scales).

DESCRIPTION OF THE FOSSILS

In view of the small amount and conditions of preservation of the fossil material of the discovered conifers, only brief descriptions and comparisons of the fossils are given, however, accompanied with instructive illustrations.

CONIFEROPSIDA

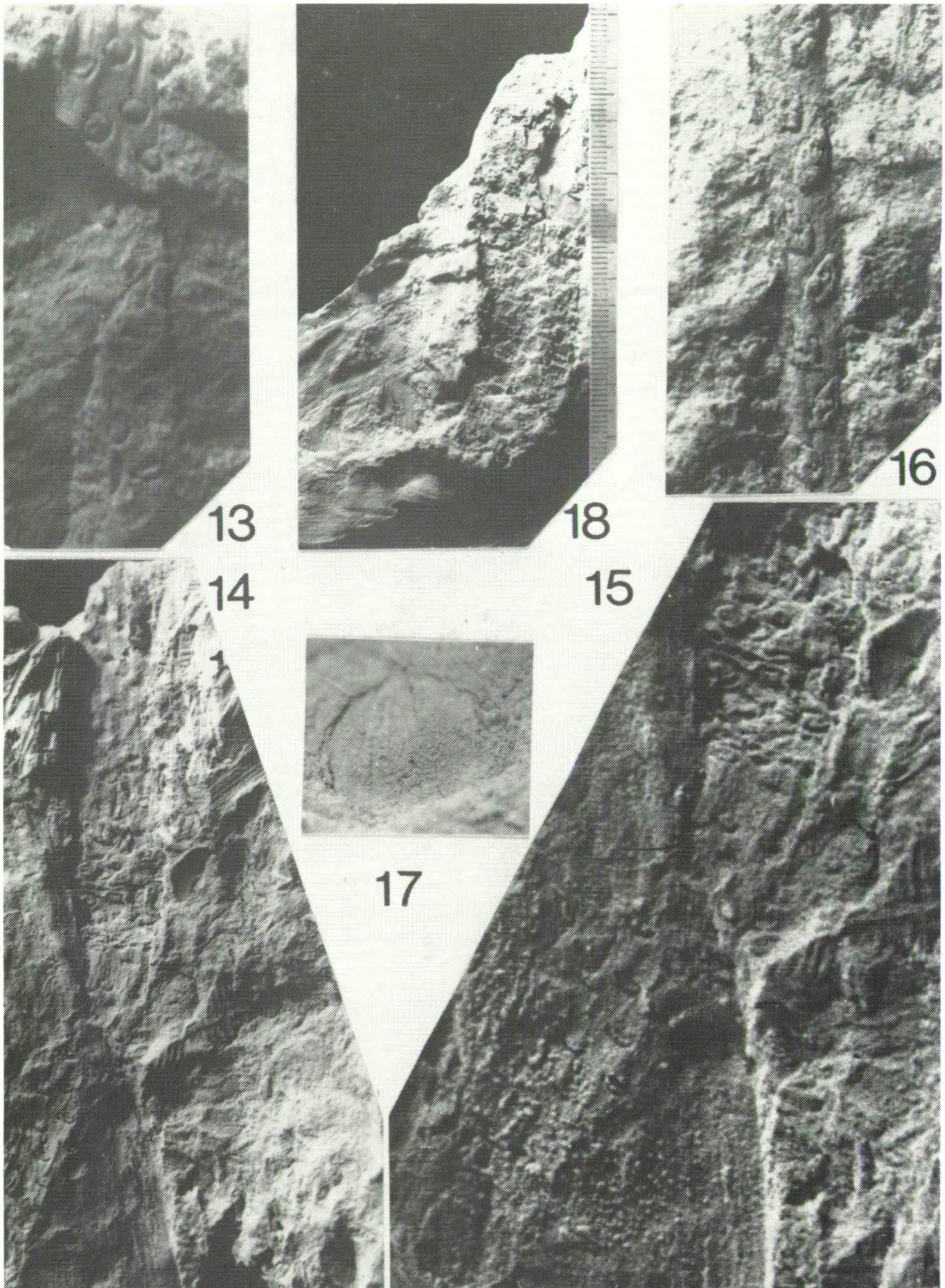
CONIFERALES

Pinus sp. (Plate 1.4., fig. 13—15, text-fig. 1.10.—1.12.)

The specimen shown in fig. 13, Plate 1.4., and text-fig. 1.10. represents an impression of a fragment of *Pinus* sp. stem. The fragment is 5 cm in length and about 6 mm broad. Dwarf shoot scars and crescent-shaped scars of subtending scale leaves

Plate 1.4. ►

13. *Pinus* sp. Impression of a stem fragment. Specimen H 64. Magnification ca 2 x.
14. *Pinus* sp. Impression of another stem fragment, showing scale zone at about the middle of the specimen and slightly broader than the rest of the stem. Specimen H 54. Magnification 1.2 x.
15. *Pinus* sp. The same, before revealing the portion of the stem above the broad zone of scales. Specimen H 54. Magnification ca 2 x.
16. *?Araucaria* twig showing prominent ?leaf scars. Specimen H 51. Magnification ca 2.5 x.
17. Seed or scale impression. Specimen H 41. Magnification 3.5 x.
18. Impression of a ?cone fragment. Specimen H 5. Magnification 0.7 x.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are clearly shown. The scar is 1.8 mm broad and 1.5 mm high. Figures 14 and 15 of Plate 1.4., and text-fig. 1.11. and 1.12. show another stem fragment most probably belonging to the same species of *Pinus*. The fragment is about 6 cm long and 6 mm broad.

It was first thought that the stem was terminated by a peculiar small head or cone as shown in fig. 15 of Plate 1.4., and text-fig. 1.12. However, on careful comparison with stems of similar size of extant *Pinus* species it became clear that the supposed cone corresponds to the zone of crowded rhomboidal scales usually present between long shoots of successive growing seasons. Accordingly, we "excavated" above the supposed cone and the remainder of the stem-fragment was revealed, as shown in Fig. 14 of Plate 1.4. and in text-fig. 1.11. This shows how far exact the agreement is between this fossil and extant *Pinus* species.

Fragment of an *?Araucaria* twig (Plate 1.4., fig. 16, text-fig. 1.13.)

An axis fragment under 5 cm in length and about 3 mm broad (Plate 1.4., fig. 16 and text-fig. 1.13.) is referred to *Araucaria* with hesitation. The axis bears more than 10 ?leaf cushions arranged in a regular manner. Every cushion has an elongate central ?leaf scar or bundle scar.

Fragment of a ?leaf (Plate 1.5., fig. 21, text-fig. 1.14.)

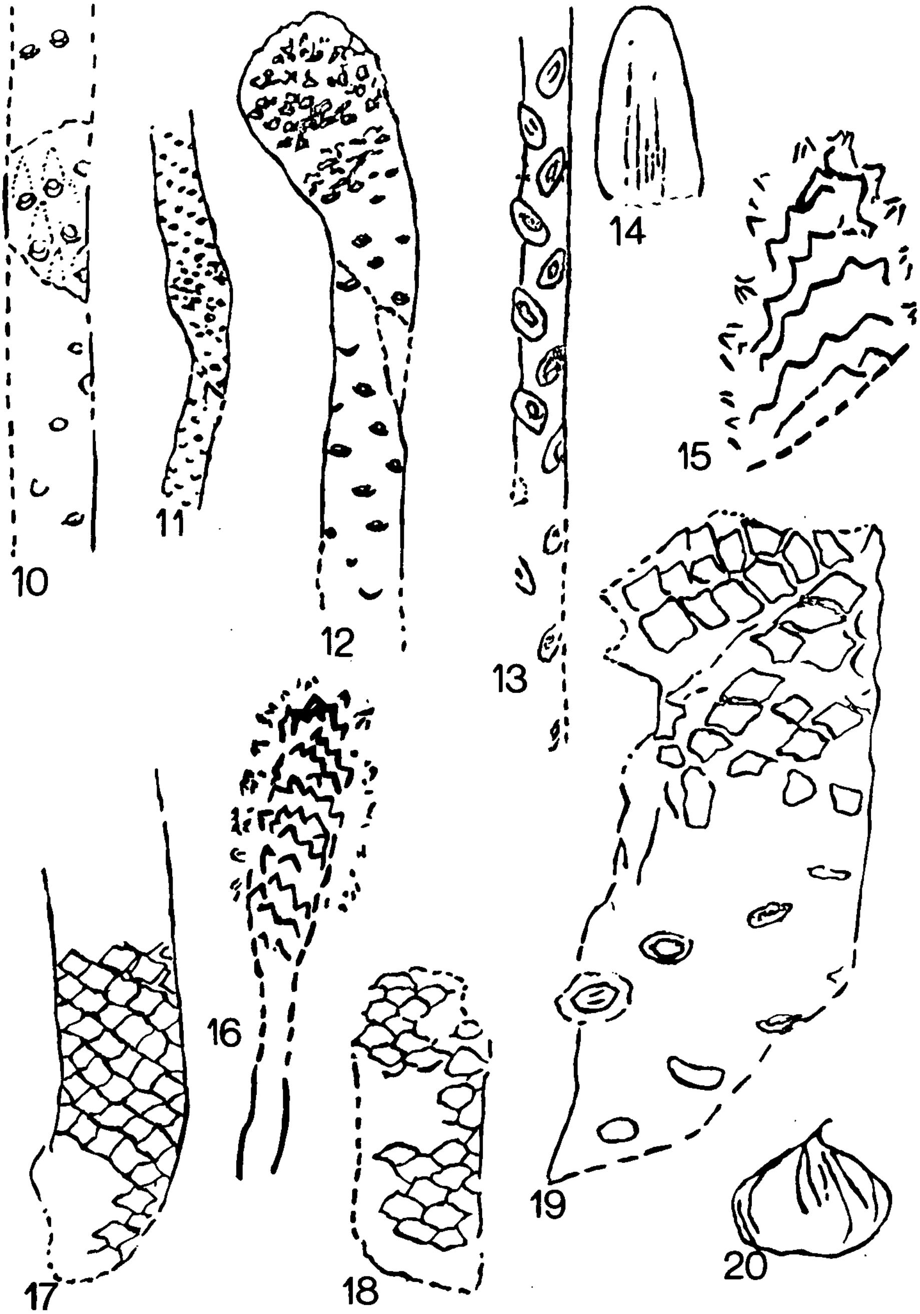
This ?leaf fragment is 3 cm long and 1.5 cm at broadest part. Longitudinal paralell lines probably represent leaf veins.

Impression of a cone (Plate 1.5., fig. 20, text-fig. 1.15., 1.16.)

Text-fig. 16 shows line drawing of cone found in slab No. H. 28. Portion of the counter part of this cone is shown in Fig. 20 of Plate 1.5., and text-fig. 1.15. The cone is about 5 cm long and 1.5 cm at the broadest part. The scales of the cone are spirally arranged. There are thin red coloured objects surrounding the cone. These objects perhaps represent delicate extensions of the cone scales. The preservation is not as good as in other associated fossils. This means that this cone was perhaps young; consisting of somewhat soft tissues. Other interpretations, however, are also possible.

Fragment of a ?cone (Plate 1.4., fig. 18, plate 1.5., fig. 19, text-fig. 1.17., 1.18.)

A fragment of a ?cone impression is shown in fig. 18 of Plate 1.4., and text-fig. 1.17. Its counter part is shown in fig. 19 of Plate 1.5., and text-fig. 1.18. The ?cone is about 5 cm long and 2 cm broad. The spirally arranged rhomboidal scars are horizontally extended being about 7 mm broad and 5 mm high. That this specimen represents an impression of a stem covered with persistent leaf bases is a probability which is not entirely excluded.



Text-figs. 1.10.—1.20.

1.10.—1.12. *Pinus* sp.
1.13. Fragment of an *?Araucaria* twig
1.14. Fragment of a ?leaf
1.15., 1.16. Impression of a cone
1.17., 1.18. Fragment of a ?cone
1.19. A stem fragment with a ?cone base attached
1.20. Impressions of seeds or ovuliferous scales

A stem fragment with a ?cone base attached (Plate 1.5., fig. 22, text-fig. 1.19.)

Plate 1.5., fig. 22 and text-fig. 1.19. show a stem fragment with spirally arranged leaf scars followed upwards by dense, spirally arranged rhomboidal scars. The stem is about 3 cm broad and 8 cm at longest part. The upper portion of the specimen, containing the rhomboidal scars, probably represents a cone base. Another possible interpretation is that this specimen represents a several years old conifer stem such as *Pinus*. In this case the upper portion of the specimen represents the zone of dense scales usually present between long shoots of successive growing seasons. At this zone also branching of the stem usually occurs in extant *Pinus* species.

Impressions of seeds or ovuliferous scales (Plate 1.4., fig. 17, text-fig. 1.20.)

Nine seed or scale impressions were met with in five specimens of the collection. One of these seeds (or scales) is shown on Plate 1.4., fig. 17, and text-fig. 1.20. The seed (or scale) is rounded or oval in shape. It is generally longer than broad but a single specimens was found to be broader than long (6×8 mm). The seed (or scale) is about 7.5 mm long and 5.5 mm broad. Extreme lengths recorded are 6 mm and 12 mm. Extreme breadths being 5 mm and 9 mm.

COMPARISONS

The above described specimens will now be compared with extinct and extant plants in the same order as they came in the description of the fossils.

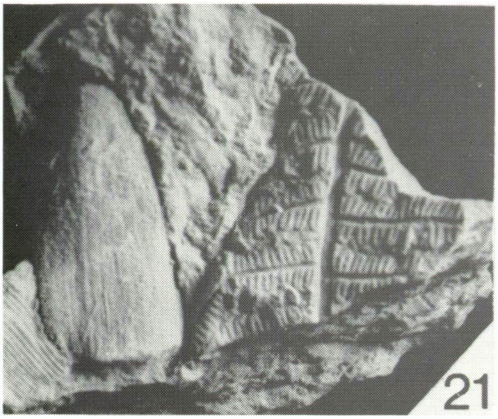
The two stem fragments referred to as *Pinus* sp. are identical with extant species of *Pinus*. The similarity is remarkable concerning: branch size, curvature, leaf and shoot scars, and the region of crowded rhomboidal scales etc...

The twig impressions referred to as *?Araucaria* is best compared with extant species of *Araucaria,* e.g. *A. bidwillii.* In this species defoliated branchlets have more or less the same shape, size and arrangement of leaf scars as in the fossil specimen concerned. There is also a probability that this fossil represents a cone axis that has shed its seeds.

The fossil specimen referred to as a ?leaf fragment does not offer much for comparison. However, we may mention the fossil *Ginkgoalian* leaf *Eretmophyllum lovisatoi* described by EDWARDS (1929a) from the Middle Jurassic of Sardinia as a possible material for comparison. EDWARD's specimen is, however, longer, and narrower than that of Abu Darag. Leaves of certain species of the extant genus *Agathis* may also be mentioned in this respect. Abu Darag's specimen may even represent a fragment of a cycadophyte pinna.

Plate 1.5. ►

19. Counter part of the specimen shown in fig. 18 of Pl. 1.4. Specimen H 5. Magnification 1.25 x.
20. The apical portion of a conifer cone. Specimen H 28. Magnification ca 2 x.
21. The apical portion of a ?leaf. Specimen H, (Kh) 3. Magnification 1.15 x.
22. Stem impression with a ?cone base attached. Specimen H 84. Magnification 1.35 x.



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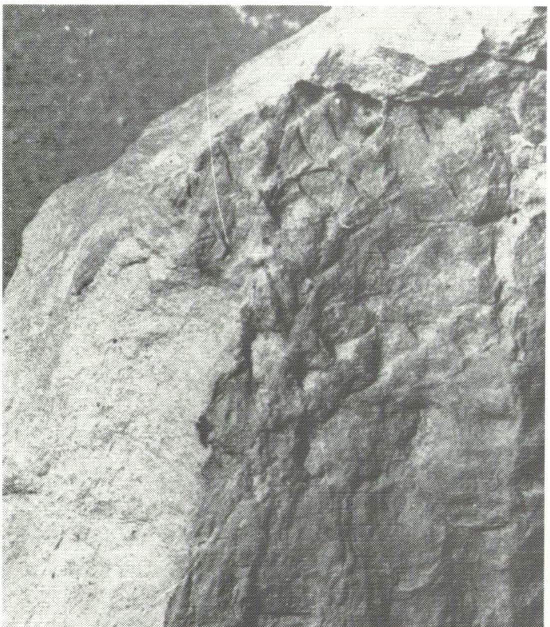

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The cone shown in text-fig. 16 is somewhat similar to *Tomaxiella biforme;* a female coniferous cone described and illustrated by ARCHANGELSKY (1968) from the Lower Cretaceous of Patagonia. *Picea excelsa;* a cone described and illustrated by SEWARD (1919) and SZÁFER (1954) from Tertiary deposits and, *Pseudotsuga douglasii* a cone described and illustrated by POTONIÉ (1921) from Carboniferous strata are two examples resembling Abu Darag's cone to a certain degree.

The specimen referred to as a fragment of a ?cone (text-fig. 1.17., 1.18.) is somewhat similar in size and some other respects to the cone *Pinostrobus cylindroides* described and illustrated by MARIE STOPES (1915) from the Lower Cretaceous of Britain. It is also similar to the cone *Pinites dunkeri* as described and illustrated by CARRUTHERS (1866).

The specimen shown in text-fig. 1.19. and referred to as "a stem with a ?cone base attached" is comparable to several years old branches of extant *Pinus* sp. at their branching points as previously described. The upper portion of the fossil specimen may be compared also with the Jurassic cone *Araucarites sphaerocarpus* as illustrated by SEWARD (1919).

The nine impressions referred to as "seeds or ovuliferous scales" show great resemblances to ovuliferous scales and seeds of certain fossil plants. For example they are closely similar in size and shape to the Jurassic ovuliferous scale *Onthodendron florini (?Araucariaceae)* as described and illustrated by SAHNI and RAO (1933). Also to the Cainozoic cone scale *Doliostrobus* sp. *(Araucariacites gurnardi)* as illustrated by REID and CHANDLER (1926). They are also closely allied to the Jurassic fossil *Strobilites milleri* which is believed to be a seed (or a seed associated with scale) by SEWARD and BANCROFT (1913). The Jurassic coniferous seed *Allicospermum baiereanum* TRALAU (1966) is also allied to the fossils of Abu Darag.

Plant microfossils

The following samples were investigated palynologically:

Sample, No 1: comes from Early Cretaceous beds (Malha Formation), from North of Wadi El-Hommar, in the souther cliffs of El-Tih Plateau, Sinai.

Sample, No 5, and 6: come from Abu Darag (bed g of section H). Age of the bed is assumed to be Lower Cretaceous.

Reference number of sample No 5: H_{68}

Reference number of sample No 6: F_{12}

The geographical position of the samples investigated is represented on text-fig. 1.21.

Taxonomy of the plant micro-remnants

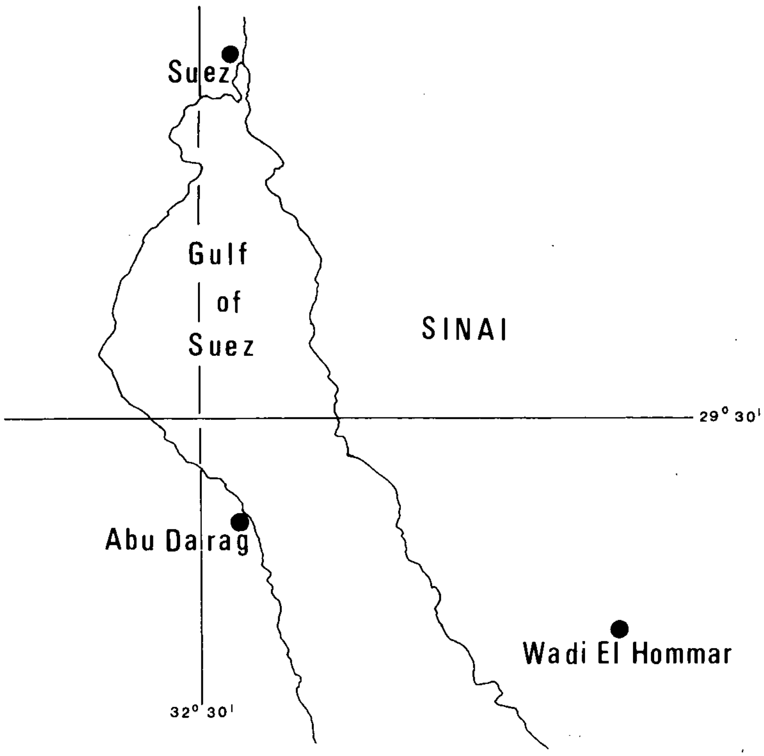
Spores

Fgen.: *Cyathidites* COUPER 1953

C. cf. *minor* COUPER 1958 (Plate 1.6., fig. 5, 6)

Fgen.: *Dictyophyllidites* COUPER 1958

D. harrisii COUPER 1958 (Plate 1.6., fig. 3,4)



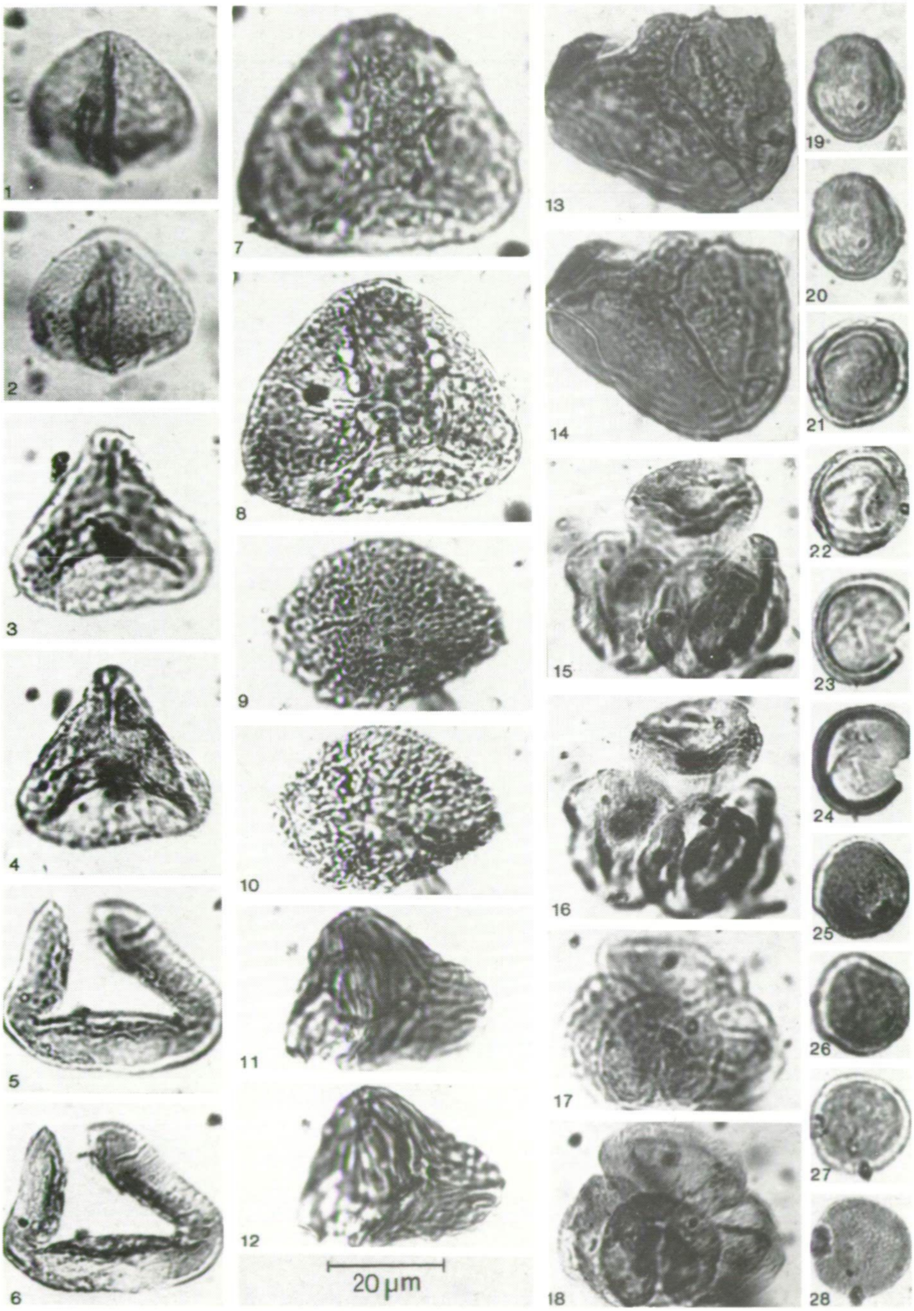
Text-fig. 1.21.

Sketch map showing the geographical position of the samples No 1, 5 and 6.

Fgen.: *Granulatisporites* (IBR. 1933) R. Pot. et. Kr. 1954
G. fsp. (Plate 1.6., fig. 9, 10)
Fgen.: *Vadaszisporites* DEÁK et COMBAZ 1867
Cf. *V.* fsp. (Plate 1.6., fig. 7, 8)
Fgen.: *Foveotriletes* (VAN DER HAMMEN 1954) ex R. POT. 1956
F. fsp. fvar. *triplan* (Plate 1.6., fig. 1, 2)
Fgen.: *Cicatricosisporites* R. POT. et GELL. 1933
C. venustus DEÁK 1963 (Plate 1.6., fig. 11, 12)
Fgen.: *Polypodiaceoisporites* R. POT. 1951
Cf. *P.* fsp. (Plate 1.6., fig. 13, 14)

Pollen grains

Fgen.: *Classopollis* PFLUG 1953
C. torosus (REISSINGER 1950) COUPER 1958 em. BURGER 1965 (Plate 1.6., fig. 15—18)
C. minor POCOCK et JANS. 1961 (Plate 1.6., fig. 17—20)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◀ Plate 1.6.

1,2. *Foveotriletes* fsp. fvar. *triplan,* slide: 1—1, cross-table number: 17.1/103.6.
3,4. *Dictyophyllidites harrisii* COUPER 1958, slide: 1—5, cross-table number: 99.0/113.6.
5,6. *Cyathidites* cf. *minor* COUPER 1958, *Cyatheaceae,* slide: 1—4, cross-table number: 19.7/103.9.
7,8. Cf. *Vadaszisporites* fsp., *Lycopodiaceae,* slide: 1—2, cross-table number: 7.6/118.2.
9,10. *Granulatisporites* fsp., slide: 1—5, cross-table number: 9.9/117.8.
11,12. *Cicatricosisporites venustus* DEÁK 1963, *Schizaeaceae, Anemia,* slide: 1—3, cross-table number: 17.6/111.1.
13,14. Cf. *Polypodiaceoisporites* fsp., cf. *Pteridaceae,* slide: 1—4, cross-table number: 10.0/105.5.
15,16. *Classopollis torosus* (REISSINGER 1950) COUPER 1958 em. BURGER 1965, *Cheirolepidaceae,* slide: 1—4, cross-table number: 8.9/113.2.
17,18. *Classopollis torosus* (REISSINGER 1950) COUPER 1958 em. BURGER 1965, *Cheirolepidaceae,* slide: 1—2, cross-table number: 10.2/107.3.
19,20. *Classopollis minor* POCOCK et JANS. 1961, *Cheirolepidaceae,* slide: 1—3, cross-table number: 8.6/112.7.
21,22. *Circulina parva* BRENNER 1963, *Cheirolepidaceae,* slide: 1—5, cross-table number: 18.2/111.3.
23,24. *Circulina parva* BRENNER 1963, *Cheirolepidaceae,* slide: 1—7, cross-table number: 16.9/117.4.
25,26. *Circulina parva* BRENNER 1963, *Cheirolepidaceae,* slide: 1—4, cross-table number: 16.7/118.1.
27,28. *Granuloperculatipollis* fsp., slide: 1—9, cross-table number: 4.3/112.6.

Fgen.: *Circulina* MALYAVKINA 1949
C. parva BRENNER 1963 (Plate 1.6., fig. 21—26)

Fgen.: *Granuloperculatipollis* VENK. et GÓCZ. 1964
G. fsp. (Plate 1.6., fig. 27, 28)

Fgen.: *Inaperturopollenites* (PFLUG 1953 ex TH. et PF. 1953) em. R. POT. 1958
I. dubius (R. POT. et VEN. 1934) TH. et PF. 1953 (Plate 1.7., fig. 1—4)

Fgen.: *Sigmopollis* HEDLUND 1965
S. fsp. (Plate 1.7., fig. 5—8)

Fgen.: *Eucommiidites* ERDTMAN 1948
E. troedssonii ERDTMAN 1948 (Plate 1.7., fig. 9—12)

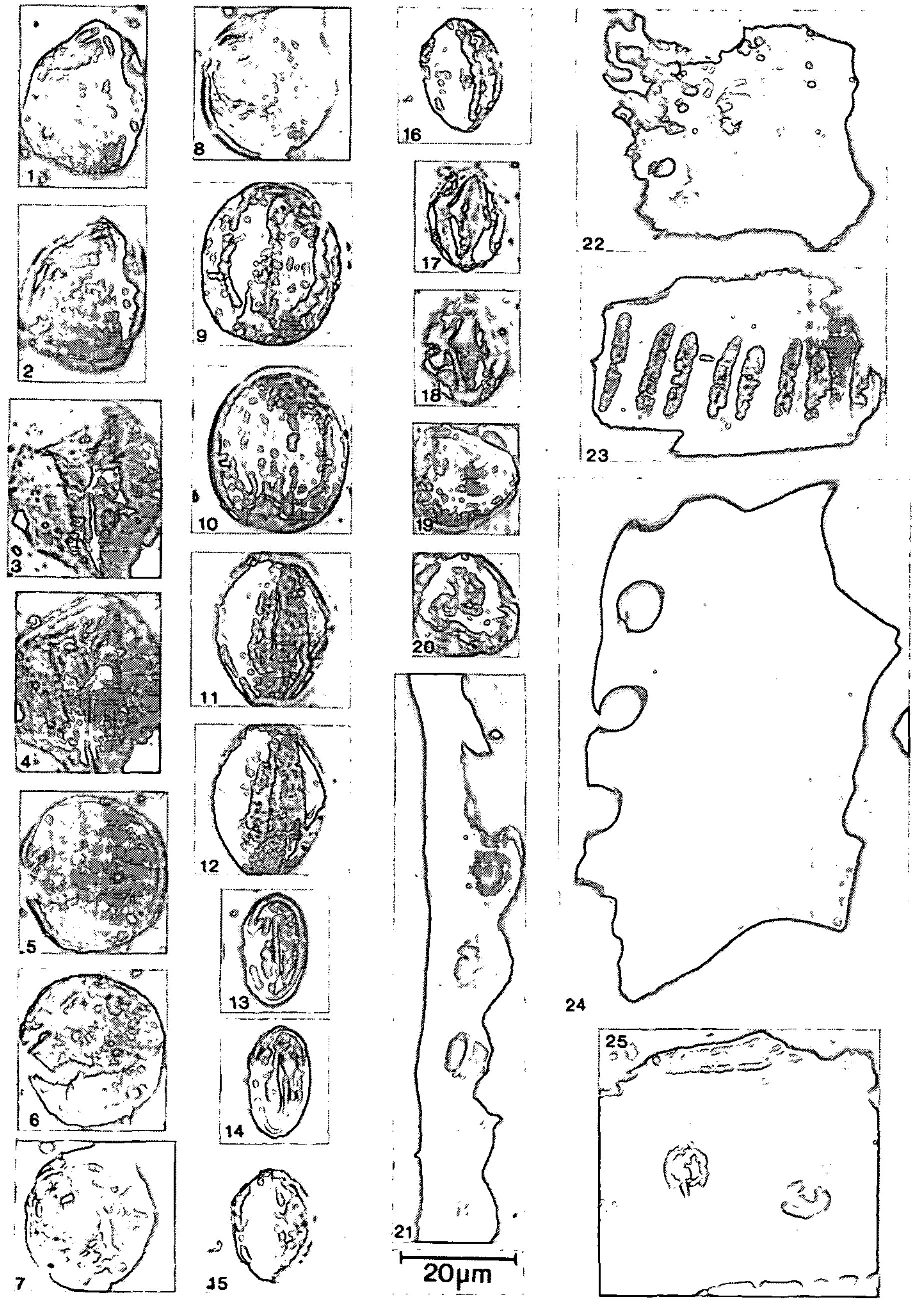
Fgen.: *Cupuliferoidaepollenites* R. POT., THOMS. et THIERG. 1950
C. parvulus (GROOT et PENNY 1961) DETTMANN 1973 (Plate 1.7., fig. 13, 14)
C. cf. *parvulus* (GROOT et PENNY 1960) DETTMANN 1973 (Plate 1.7., fig. 15, 16)

Fgen.: *Retitricolpites* (Van der Hammen 1956) VAN DER HAMMEN et WIJMSTRA 1964
R. ecommoyensis LAING 1975 (Plate 1.7., fig. 17, 18)

Fgen.: *Triorites* (ERDTMAN 1947, COOKSON 1950) ex COUPER 1958 emend. R. POT. 1960
Cf. *Triorites* fsp. (Plate 1.7., fig. 19, 20)

Plant tissue remnants

Epidermis fragment of *Monocotyledonopsida* type (Plate 1.7., fig. 22)
Tracheids of *Pteropsida* type with scalariform pittening (Plate 1.7., fig. 23)
Gymnosperm secondary xylem fragments, tracheids with bordered pits (Plate 1.7., fig. 21, 24, 25)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◀ Plate 1.7.

1,2. *Inaperturopollenites dubius* (R. POT. et VEN. 1934) Th. et Pf. 1953, *Taxodiaceae* v. *Cupressaceae,* slide: 1—2, cross-table number 21.8/107.2.
3,4. *Inaperturopollenites dubius* (R. POT. et VEN. 1934) TH. et PF. 1953, *Taxodiaceae* v. *Cupressaceae,* slide: 1—1, cross-table number: 6.8/111.6.
5,6. *Sigmopollis* fsp., slide: 1—3, cross-table number: 20.9/108.9.
7,8. *Sigmopollis* fsp., slide: 1—1, cross-table number: 20.9/118.1.
9,10. *Eucommiidites troedssonii* ERDTMAN 1948, slide: 1—6, cross-table number: 5.2/105.3.
11,12. *Eucommiidites troedssonii* ERDTMAN 1948, slide: 1—2, cross-table number: 14.5/112.2.
13,14. *Cupuliferoidaepollenites parvulus* (GROOT et PENNY 1961) DETTMANN 1973, slide: 1—4, cross-table number: 4.6/113.6.
15,16. *Cupuliferoidaepollenites* cf. *parvulus* (GROOT et PENNY 1961) DETTMANN 1973, slide: 1—6, cross-table number: 17.1/113.2.
17,18. *Retitricolporites ecommoyensis* LAING 1975, slide: 5—10, cross-table number: 18.5/103,4.
19,20. Cf. *Triorites* fsp., slide: 1—2, cross-table number: 21.2/102.9.
21. Gymnosperm secondary xylem fragment, with bordered pits, slide: 1—2, cross-table number: 21.2/102.9.
22. Epidermis fragment of *Monocotyledonopsida* type, slide: 1—2, cross-table number: 19.9/114.2.
23. Tracheid of *Pteropsida* type with scalariform pitting, slide: 6—10, cross-table number: 14.3/108.7.
24. Gymnosperm secondary xylem fragment, with bordered pits, slide: 1—2, cross-table number: 12.1/111.7.
25. Gymnosperm tracheid fragment, with bordered pits, slide: 1—3, cross-table number: 21.6/108.5.

QUANTITATIVE DATA OF THE PLANT MICROFOSSILS

Sample No 1

Rich in plant microfossils, the spores and pollen grains are relatively well preserved. The greatest part of the enumerated and represented plant microfossils were observed in this sample. The quantitative data in the most important botanical groups are as follows:

	%
PTERIDOPHYTA	
Gleicheniaceae	2.5
Schizaeaceae	0.2
Varia	0.2
GYMNOSPERMATOPHYTA	
Inaperturopollenites dubius	25.0
"*Classopollis* group"	62.0
Eucommiidites troedssonii	6.9
ANGIOSPERMATOPHYTA	
Mostly *Longaxones*	0.2
INCERTAE	
Sigmopollis	3.0

Sample No 5

Very poor in sporomorphs. *Angiosperm* pollen grains (*Retitricolporites ecommoyensis*) and epidermis fragments of *Monocotyledonopsida* type were observed. The sample contains a great number of black coal fragments.

Sample No 6

The slides are rich in dark coloured, burnt plant tissue remnants. A very poorly preserved *Cyathidites* cf. *minor* was observed only.

INTERPRETATION OF PLANT MICROFOSSILS

1. The geological age of the samples, investigated on the basis of the spore-pollen assemblages, may be interpreted in different ways. The sample No 1 is without doubt of Lower Cretaceous age. The so-called Middle Mesozoic type spores and *Gymnospermatophyta* pollen grains *(Classopollis, Circulina, Eucommiidites)* together with the psilate and reticulate *Longaxones* angiosperm pollen grains refer to Aptian — Albian stage. The scarce *Brevaxones* pollen grains (cf. *Triorites)* is relatively younger in this respect. In Europe, the appearance of the first brevaxonate pollen grains is in the Upper Cenomanian. The plant micro-remnants of sample No 5, are a little problematical. The occurrence of *Retitricolporites ecommoyensis* refers to a Lower Cretaceous age. But the *Monocotyledonopsida* type epidermis fragment is unusual in this period. On the other hand, taking into consideration the new concepts of the evolution of the angiosperm pollen grains beside the early monosulcate type, the inaperturate one may also be presumed. The peculiar, angiosperm exine ultrastructure described from the nearly inaperturate Mesozoic gymnosperm pollen grain (*Spheripollenites scabratus* COUPER 1958) by KEDVES and PÁRDUTZ (1973) supports a so-called "inaperturate lineage" and also supports the polyphyletic evolution of the angiosperm pollen grains. ZAVADA (1984) published a new scheme about the most important evolutionary trends of the monocotyledonous pollen grains. The inaperturate type was derived from the monosulcate one. Here we propose to derive the inaperturate angiosperm pollen type from inaperturate gymnosperm pollen grains similarly to the monosulcate evolutionary lineage, e.g.: The early monosulcate pollen type originates from angiosperm pollen grains which are also of monosulcate morphology. In this way this early occurrence of the epidermis remnant of monocotyledonous type is not so surprising.

2. In connection with the ecological conditions of the sedimentation of the samples investigated it may be emphasized, that we have not observed hystrichosphaerids or such kind of micro-remnants which indicate salt water or brackish water conditions. In the reconstruction of the zonation of the vegetation it is only sample No 1 which contains a suitable quantity of sporomorphs. On the basis of the composition of the sporomorph a similarity may be established with the riparian vegetation of the Jurassic carbonate manganese ore layers published earlier (KEDVES and SIMONCSICS, 1964). The zonation was established as follows:

1. Open swamp, with *Pleurozonaria* = *Crassosphaeridae,* and *Hystrichosphaeridae.*
2. *Filicinae* zone.
3. *Cycadineae (Ginkgoinae)* zone.
4. *Cheirolepidaceae (Brachyphyllum, Cheirolepis, Pagiophyllum)* zone.
5. *Spheripollenites* producing *Coniferae* zone.

In our sample (No 1) the *Classopollis* type pollen grains is dominant, in this way, this refers to the *Cheirolepidaceae* zone. The important quantity of the inaperturate pollen grains refers to a *Taxodiaceae* — *Cupressaceae* zone, which may be behind or before the *Cheirolepidaceae* zone. To solve this problem of the zonation we do not have up till now enough information.

3. Finally for the climate, the tropical fern spores *(Schizaeaceae, Gleicheniaceae)* may be mentioned.

General discussion

The conclusions based on the data of the plant macro- and microfossils are not always the same. This phenomenon was established several times by previous researchers. This phenomenon is related to the different conditions of the fossilization processes. In this place it is necessary to emphasize newly, that the chemical compounds of the leaves, fruits, seeds, spores and pollen grains are different, consequently diagenesis, selective fossilization and degradation are also different. To get the best interpretation we believe that it is one solution, to take the whole remnant matter together and synthetize their informations, and not interpret the macro- and micro-remnant assemblages in opposition. Every method has its advantages and disadvantages, the pluridisciplinary character of the palaeobotanical researches is a necessity.

Acknowledgements

We wish to thank Mr. K. KANDEEL the Chairman of the Egyptian Gypsum, Quarries, and Marble Company and Mr. E. FARAG (E. G. Q. and M. Comp.) for their kind help.

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